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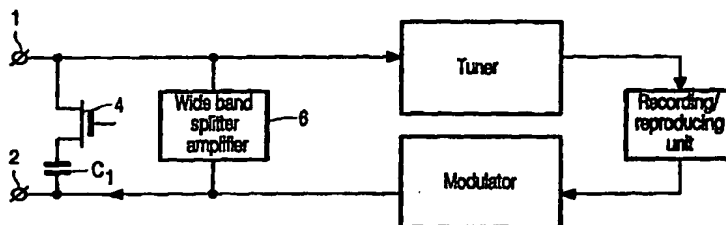
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04N 5/775		A2	(11) International Publication Number: WO 99/55085
			(43) International Publication Date: 28 October 1999 (28.10.99)
(21) International Application Number: PCT/IB99/00607		(81) Designated States: CN, JP, KR, SG, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 8 April 1999 (08.04.99)			
(30) Priority Data: 98201218.9 16 April 1998 (16.04.98) EP		Published Without international search report and to be republished upon receipt of that report.	
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(54) Title: VIDEO RECORDER/REPRODUCER APPARATUS



(57) Abstract

A video recorder/reproducer apparatus is provided with an antenna input terminal (1), an antenna output terminal (2), a splitter circuit (6) having an input coupled to the antenna input terminal and an output coupled to the antenna output terminal, a tuner circuit (tuner) having an input coupled to the antenna input terminal, and an output coupled to a recording/reproducing unit. A modulator unit is present, having an input coupled to the output of the recording/reproducing unit and an output which is coupled to the antenna output terminal (2). Supply voltage generator means (38) for generating a supply voltage for at least the splitter circuit (6) is present. In accordance with the invention, switching means (4, 8) are present having a first terminal coupled to the antenna input terminal (1) and a second terminal coupled to the antenna output terminal (2). The switching means realize an internal connection between its two terminals in response to the supply voltage generator means (38) being switched off and for realizing an open connection between its two terminals in response to the supply voltage generator means being switched on. The switching means comprise a FET (4), having its first and second main electrodes coupled to the first and second terminal, respectively, of the switching means.

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Video recorder/reproducer apparatus.

The invention relates to a video recorder/reproducer apparatus, provided with

- an antenna input terminal,
 - an antenna output terminal,
 - a splitter circuit having an input coupled to the antenna input terminal and an output coupled
 - 5 to the antenna output terminal,
 - a tuner circuit having an input coupled to the antenna input terminal, and an output,
 - a recording/reproducing unit having an input coupled to the output of the tuner circuit, and an
 - output,
 - a modulator unit having an input coupled to the output of the recording/reproducing unit and
 - 10 an output which is coupled to the antenna output terminal,
 - supply voltage generator means for generating a supply voltage for at least the splitter circuit.
- The invention also relates to switching means for use in the apparatus.

- 15 USP 3,824,335 discloses a video recorder/reproducer apparatus provided with a passive splitter circuit. Present day video recorder/reproducer apparatuses, however, make use of an active splitter circuit that requires a supply voltage, for the reason that the splitter circuit generally also has an amplifier function.

- 20 A schematic block diagram of a conventional video recorder/reproducer (VCR) apparatus is given in Fig.1. Terminal 1 is the antenna input terminal and terminal 2 is the antenna output terminal for coupling to a TV apparatus. If the VCR apparatus is not used ("stand-by"), at least the wide band splitter amplifier must always be switched on to ensure reception of TV signals in the TV set. Power consumption in stand-by can be reduced if the supply voltage of the VCR apparatus can be switched off, but special measures must be taken
- 25 to ensure the reception of TV signals in the TV set.

The invention aims at providing a video recorder/reproducer apparatus having a relatively low power consumption, but ensures the antenna signal to be supplied to the antenna output terminal, even if the supply voltage for the splitter circuit has been switched off.

The apparatus defined in the opening paragraph is characterized in that the
5 video recorder apparatus further comprises
- switching means having a first terminal coupled to the antenna input terminal and a second terminal coupled to the antenna output terminal, the switching means being adapted to realize an internal connection between its two terminals in response to the supply voltage generator means being switched off and for realizing an open connection between its two terminals in
10 response to the supply voltage generator means being switched on, the switching means comprising a FET (4), having its main electrodes coupled to the first and second terminal of the switching means.

The invention is based on the following recognition. If a FET (field effect transistor), more specifically a depletion type silicon Mosfet or a Mesfet, is used in its linear
15 region, this FET can be used as a variable resistor. The resistance depends on the bias voltage between Gate and Source and the pinch - off voltage of this FET. If this bias voltage is lower than the pinch - off voltage the resistance of the FET is infinite. If this bias voltage is much higher than the pinch - off voltage the resistance of the FET is low. Due to this, a FET can be used as a switch. At low Gate - Source voltages the FET is switched off and at high Gate -
20 Source voltages the FET is switched - on. If a FET is used with relatively low capacitances, this FET can be used as an RF (Radio Frequency) switch. With this RF switch, RF signals can be switched off and on. The newly developed BF1107 is a triode Mosfet intended for switching RF signals. If the Drain - Source voltage is set to 0V, this Mosfet is biased in its linear region. This Mosfet has a pinch - off voltage of appr. -3V. Therefore this Mosfet is
25 switched - on if the Gate - Source voltage is 0V. Together with a Drain - Source voltage of 0V this means that the Mosfet is switched - on if all bias voltages are 0V. If the Gate - Source voltage is set to a value lower than -3V this Mosfet is switched off.

30 These and other aspects of the invention will become apparent hereafter in the following figure description. The figure description shows in

figure 1 the conventional video recorder/reproducer apparatus,
figure 2 the apparatus in accordance with the invention, provided with a FET,
figure 3 a test circuit for measuring the behaviour of the switching circuit,

figure 4 the test results,
figure 5 a more elaborate circuit diagram of the switching circuit,
figure 6 a further elaborated version of the switching circuit, and
figure 7 an improved version of the switching circuit.

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Figure 2 shows an schematic embodiment of the VCR apparatus in accordance with the invention, provided with a switch, in the form of a FET 4, between the antenna terminals 1 and 2. To reduce power consumption, the switch must be conductive if the VCR supply voltage is switched off, and be non-conductive if the VCR supply voltage is switched on.

Mosfets or Mesfets could be used as switching elements. Preferably, a switch in the form of a depletion type silicon Mosfet is chosen. This Mosfet is switched on if all the supply voltages at the Mosfet are 0. The Mosfet is switched off if the Gate - Source voltage has a negative value, more negative than the pinch-off voltage of the Mosfet.

When the supply voltage of the VCR apparatus is switched on, the Mosfet switch must be switched off. In a further elaboration of the apparatus of figure 2, this can be done by connecting the Drain or the Source of the Mosfet 4 to the supply voltage via a resistor R3 and connecting the Gate to ground and adding a capacitor C₁ between the Mosfet 4 and one of the terminals 1 or 2, or by adding capacitors between the Mosfet and both terminals.

When the supply voltage = 0, then the Drain-, Source- and Gate voltages of the Mosfet switch are 0. In this situation, the antenna signal flows through the Mosfet switch to the TV set. When the supply voltage = 5V (as an example), then the Drain - and Source voltages of the Mosfet switch are 5V. The capacitor C₁ ensures that the Drain and the Source voltages are equal. The Gate voltage is 0 (Gate is grounded) and the antenna signal flows through the VCR as usual. It should be further noted that, in this circuit construction, the Mosfet acts as a bidirectional switch.

A newly developed depletion type silicon Mosfet that is of specific use in this application is the BF1107 Mosfet. This Mosfet has the specific advantage over GaAs Mesfets that it is cheaper. Further, an advantage of the Mosfet is low losses. In the 'on'- state of the Mosfet, the losses must be low, because losses determine, for a large amount, the increase of the noise that may become visible on the screen of the TV set. In the 'off'- state, the isolation must be high because the oscillator signal from the modulator must be kept very small at the antenna input. The main advantage of applying the BF1107 as a switch for the passive loop

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through is that this Mosfet uses no current. Not in the on state and not in the off state. Switching is done only with voltages.

The performance of the RF switch 4 BF1107 was measured in a circuit as given in Fig. 3. In this circuit, isolation and losses as a function of frequency were measured. To
5 measure the isolation properties of the switch 4 when it is switched off, a voltage V_s , which is in the present circuit equal to 5 Volts, should be applied to the terminal 10 in the circuit of figure 3. To measure the properties of the switch when it is in its conductive state, a voltage equal to 0 Volts should be applied to the terminal 10. The gate of the switch 4 is connected to a point 12 of constant potential (ground). The results of these measurements are given in Fig.
10 4, where the losses are plotted along the left hand side of the diagram in figure 4 and the isolation is plotted along the right hand side of the diagram. Curve 22 in the diagram of figure 4 shows the behaviour of the losses, whereas the curve 20 shows the isolation as a function of frequency.

The isolation (Mosfet is switched off) in the testcircuit is mainly determined by
15 the feedback of the Mosfet in common Gate configuration plus the parasitic capacitance of the testcircuit between Drain and Source. This parasitic capacitance must be very small. The losses (Mosfet is switched - on) in the testcircuit are at low frequencies determined by the $R_{DS\ on}$ of the Mosfet and at high frequencies by the $R_{DS\ on}$ and the Drain - Gate and Source - Gate capacitances of the Mosfet. The parasitic capacitances of the circuit must be kept much lower
20 than the capacitances of the Mosfet.

In Fig. 2 only the principle of the application circuit of the switch in the VCR apparatus is given. In a practical embodiment of the switching circuit in the VCR, the input and output of the wide band splitter amplifier are connected to the input and output of the switching circuit. As stated above, the losses in the 'on'-situation of the switch are also
25 determined by the capacitances at the input and the output of the switch. If in the circuit of Fig.2 the Mosfet is switched on, then the wide band splitter amplifier is still connected to the RF switch. This results into higher losses. Therefore special measures are needed to reduce the influence of the presence of the amplifier on the losses. Theoretically, this can be done by disconnecting the input as well as the output of the amplifier from the switch. In practice this
30 disconnecting can be done with a switch in the form of a diode. The principle of the circuit is then as given in Fig. 5. Figure 5 shows the additional diodes 30 and 32 that function as a switch and are connected between the switching circuit 8 and the splitter unit 6.

The two diodes in Fig. 5 must have low resistance if the switching circuit 8 is on and they must have a low capacitance in both the on and off position of the switching

circuit 8. This can be realized by means of the diodes 30 and 32. With the right choice of the diodes 30 and 32, the resistance is low if the diode is forward biased and the capacitance is low if the bias voltage of the diode is 0V. Diodes that can be applied are bandswitching diodes (e.g. BA792 or BA277). If the two amplifier stages 34 and 36 of the wide band splitter circuit 5 6 are connected via the diode switches 30 and 32, respectively, then the splitter circuit 6 is "disconnected" from the switching circuit 8 when the supply voltage V_s is equal to 0V and "connected" when the supply voltage V_s is equal to 5V.

The BF1107 switch 4 is a specially developed triode Mosfet for the application as RF switch. In the on condition of the switch as well as in the off condition no DC current 10 flows through the Mosfet. The requirements in the application of the FET in a switching circuit 8 for a VCR apparatus are:

Losses: typically 2dB, max. 4dB.

Isolation: > 30dB.

This can be achieved with a BF1107 in the circuit of Fig. 6. The switching 15 circuit of Fig. 6 is further provided with a decoupling capacitor C_3 inserted between the terminal V_s and "earth". If this switching circuit is applied the supply voltage of the VCR can be switched - off in the "stand - by" condition of the VCR. The RF signal path to the T.V. set is then via the switch and not via a (power consuming) wide band splitter amplifier. The switching circuit in accordance with the invention has the advantage over prior art switching 20 circuits that it requires less components, so that it is relatively cheap.

Figure 7 shows a further improvement of the circuit of figure 6. A diode D_1 is coupled between the gate of the Mosfet 4 and the point of constant potential (ground) and further, a resistor R_d is coupled between the gate of the mosfet 4 and the power supply terminal V_s . The circuit of figure 7 shows an improved behaviour, in that the losses in the 25 conductive mode of the mosfet are decreased.

Whilst the invention has been described with reference to preferred embodiments thereof, it is to be understood that these are not limitative examples. Thus, various modifications may become apparent to those skilled in the art, without departing from the scope of the invention, as defined by the claims.

30 Further, the invention lies in each and every novel feature or combination of features.

CLAIMS:

1. Video recorder/reproducer apparatus, provided with
 - an antenna input terminal,
 - an antenna output terminal,
 - a splitter circuit having an input coupled to the antenna input terminal and an output coupled
 - 5 to the antenna output terminal,
 - a tuner circuit having an input coupled to the antenna input terminal, and an output,
 - a recording/reproducing unit having an input coupled to the output of the tuner circuit, and an output,
 - a modulator unit having an input coupled to the output of the recording/reproducing unit and
 - 10 an output which is coupled to the antenna output terminal,
 - supply voltage generator means for generating a supply voltage for at least the splitter circuit, characterized in that the video recorder apparatus further comprises
 - switching means having a first terminal coupled to the antenna input terminal and a second terminal coupled to the antenna output terminal, the switching means being adapted to realize
 - 15 an internal connection between said first and second terminals in response to the supply voltage generator means being switched off and for realizing an open connection between said first and second terminals in response to the supply voltage generator means being switched on, the switching means comprising a FET (4), having its main electrodes coupled to the first and second terminal of the switching means.
 - 20
2. Video recorder/reproducer apparatus as claimed in claim 1, characterized in that the FET has its control electrode (gate) connected to a point of constant potential (ground), not being the supply voltage.
- 25 3. Video recorder/reproducer apparatus as claimed in claim 1 or 2, characterized in that the switching means comprise an impedance (R_3) coupled between a point for receiving said supply voltage (V_s) and a main electrode of the FET.

4. Video recorder/reproducer apparatus as claimed in claim 3, characterized in that said impedance is coupled between said point for receiving said supply voltage and one of said main electrodes of the FET.
- 5 5. Video recorder/reproducer apparatus as claimed in claim 3 or 4, characterized in that the switching means further comprise a capacitor (C_3) coupled between said point for receiving said supply voltage and said point of constant potential.
6. Video recorder/reproducer apparatus as claimed in anyone of the preceding
10 claims, characterized in that a second capacitor (C_2) is coupled between one of said main electrodes of the FET and the first terminal of the switching means and a third capacitor (C_1) is coupled between the other of said main electrodes of the FET and the second terminal of the switching means.
- 15 7. Video recorder/reproducer as claimed in claim 2, characterized in that a diode (D_1) is coupled between said control electrode and said point of constant potential.
8. Video recorder/reproducer as claimed in claim 7, characterized in that a further impedance (R_d) is coupled between said control electrode and said points for receiving the
20 supply voltage.
9. Video recorder/reproducer apparatus as claimed in anyone of the preceding claims, characterized in that the FET is a depletion type silicon MOSFET.
- 25 10. Switching means for use in a video recorder/reproducer apparatus as claimed in anyone of the preceding claims.

1/3

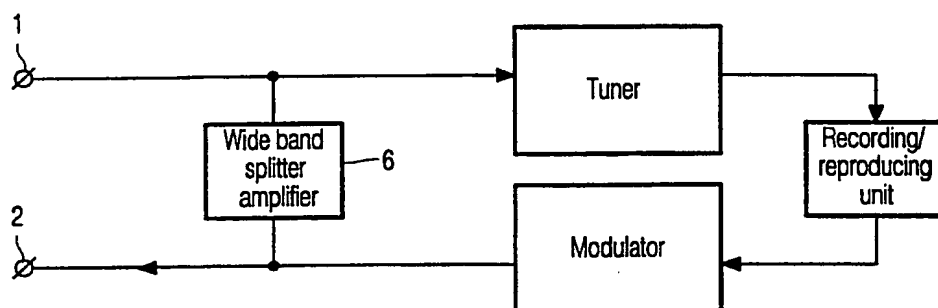


FIG. 1

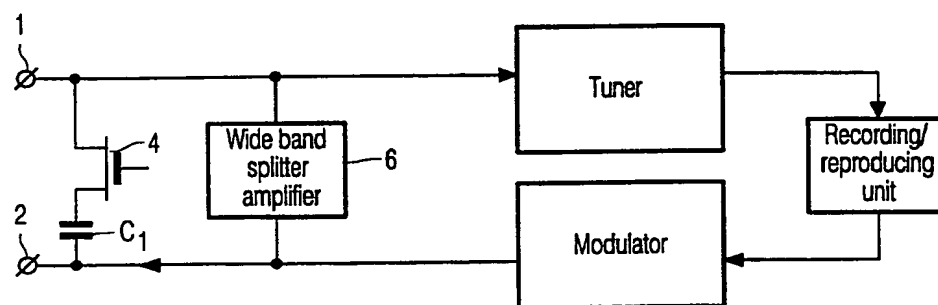


FIG. 2

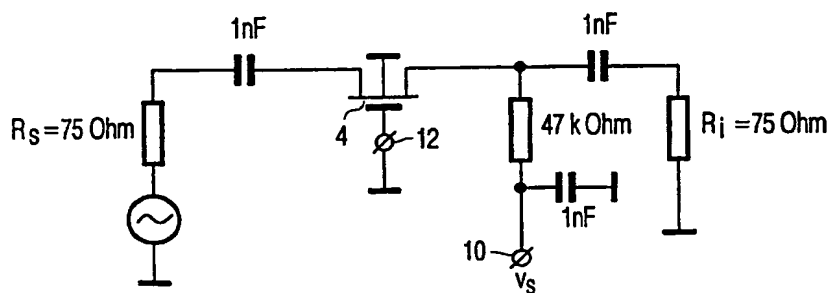


FIG. 3

2/3

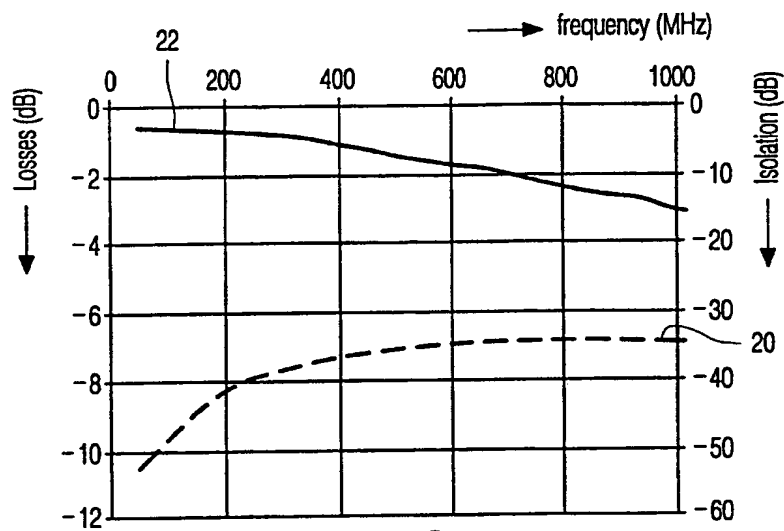


FIG. 4

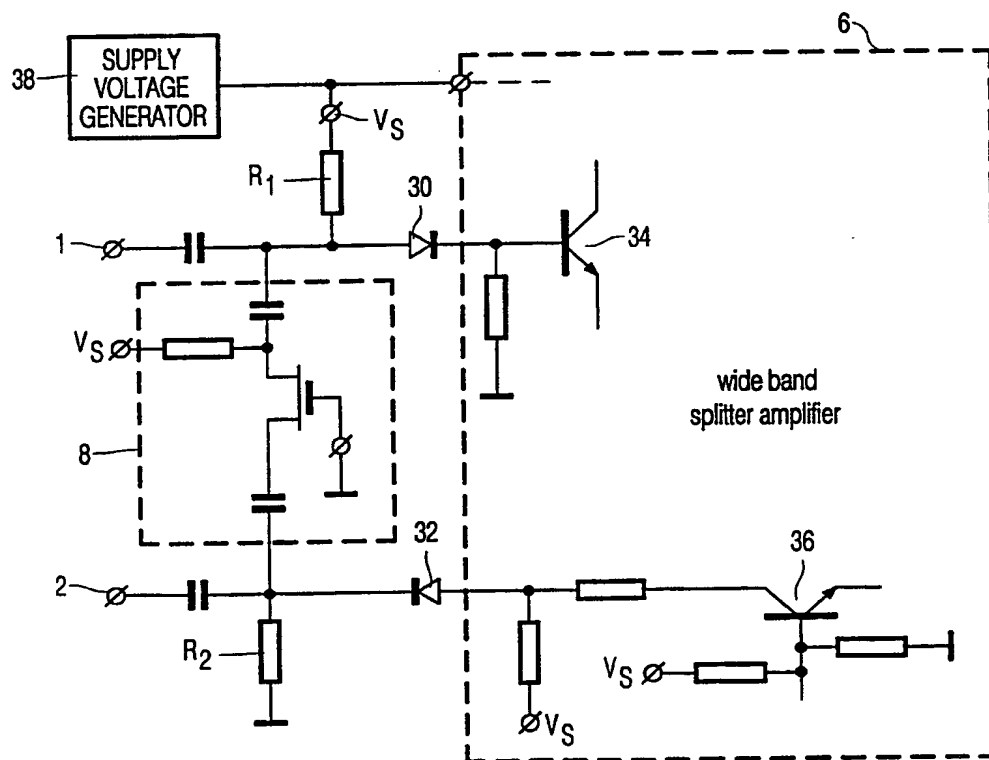


FIG. 5

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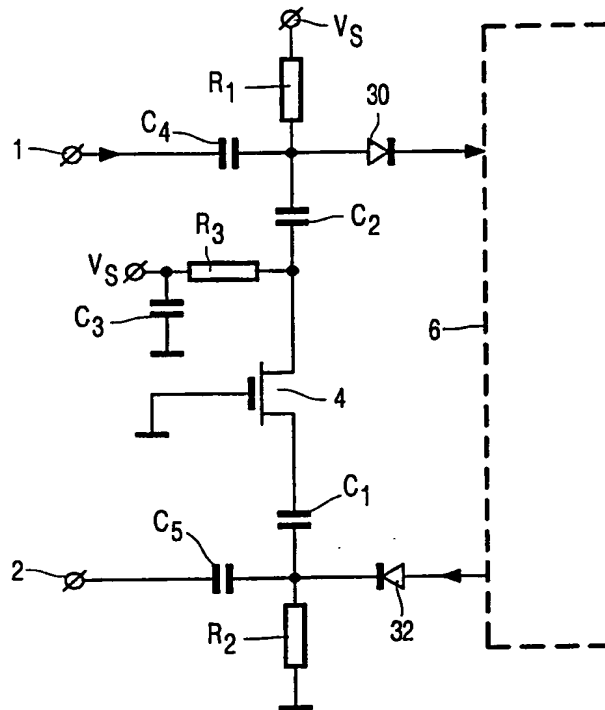


FIG. 6

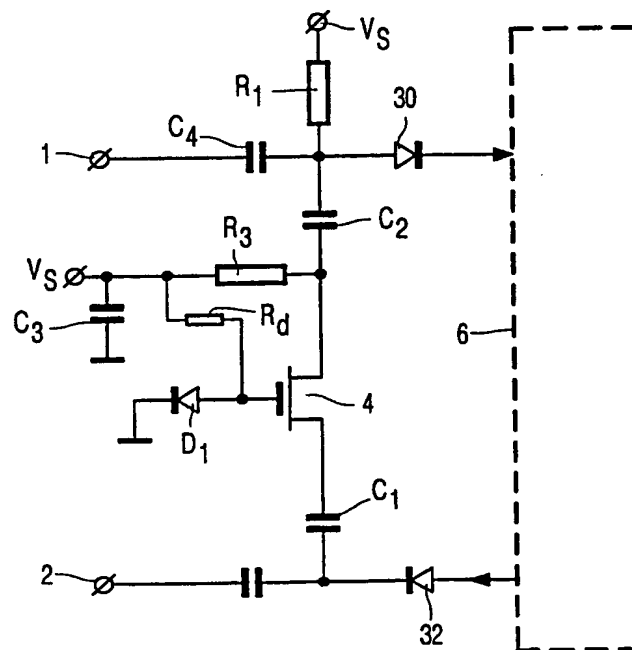


FIG. 7